TECHNICAL NOTES

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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THE AERODYNAMIC DRAG OF FIVE MODELS OF SIDE FLOATS

N.A.C.A. MODELS 51-E, 51-F, 51-G, 51-H, AND 51-J

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SUMMARY

The drag of five models of side floats was measured in the N.A.C.A. 7- by 10-foot wind tunnel. The most promising method of reducing the drag of floats indicated by these tests is lowering the angle at which the floats are rigged. The addition of a step to a float does not always increase the drag in the flying range, floats with steps sometimes having lower drag than similar floats without steps.

Making the bow chine no higher than necessary might result in a reduction in air drag because of the lower angle of pitch of the chines. Since side floats are used primarily to obtain lateral stability when the seaplane is operating on the water at slow speeds or at rest, greater consideration can be given to factors affecting aerodynamic drag than is possible for other types of floats and hulls.

INTRODUCTION

As the speeds of seaplanes increase, air drag becomes more important as a factor to be considered in float design. This fact is especially true of nonretracting inboard and outboard floats, their main function being to provide lateral stability when the seaplane is operating on the water at slow speeds or at rest.

Retractable floats seem to be one solution of the problem of drag of tip floats. A study to ascertain the relative advantages of such installations would be necessary for each type of design contemplated since retractable floats might not be suitable for use on all seaplanes.

The small amount of available data makes it difficult to design a float having the lowest air drag consistent with the hydrodynamic requirements. For this reason, air-drag tests have been made of a number of floats constructed for tests in the N.A.C.A. tank. Results of previous tests are reported in references 1 to 4 and the aerodynamic-drag tests of five side floats are reported herein.

APPARATUS AND TESTS

Models.- The models used in these tests were originally constructed for tests in the N.A.C.A. tank. They were made of wood and were varnished and polished. The lines of the models, together with the basic dimensions, are given in figures 1 to 5, and a typical float installation in the 7- by 10-foot tunnel is shown in figure 6.

Model 51-E, an outboard float, is an N.A.C.A. experimental design. Models 51-F and 51-G are models of the inboard floats of the Navy P3M-1 flying boat and the German Rohrbach Romar, respectively. Model 51-H is an inboard float from the Navy Bureau of Aeronautics design no. 121, Mark IV lines. Model 51-J, an outboard float, is from the Navy Bureau of Aeronautics plan no. 6949.

Wind tunnel.- The models were mounted on the standard force-test tripod in the N.A.C.A. 7- by 10-foot closed-throat wind tunnel, which is described in detail in reference 5.

Tests.- The tests were made at a dynamic pressure of 16.37 pounds per square foot, corresponding to an air speed of about 80 miles per hour at standard sea-level conditions. The range of pitch angles was from -10° to 16° measured from the tangent to the keel at the stern. (For models with steps, the reference line was the tangent to the keel line at the step.) As a small part of the balance-spindle support was exposed to the air, tests were also made with a dummy support in place to obtain the tare drag. No further corrections to the data were applied.

RESULTS AND DISCUSSION

The data were reduced to coefficient form by means of the relation $C_D = \frac{D}{q(vol)^{2/3}}$

where C_D is the drag coefficient.

D, drag of float.

q, dynamic pressure $(\frac{1}{2} \rho V^2)$.

vol, volume of float.

The drag coefficient is based on volume rather than area because the volume of a float is the basic design variable.

The values of the drag coefficient of the inboard floats are plotted against pitch angle in figure 7. The pitch-angle reference was the tangent to the keel in figure 7(a) and the angle for minimum drag in figure 7(b). Similar curves for the outboard floats are given in figure 8.

It is difficult to compare floats on the basis of aerodynamic drag because no suitable pitch-angle reference line has been established. The tangent to the keel line has previously been used and the pitch angle measured from this reference is usually a few degrees positive for the flying attitude; the value of the pitch angle must be known to obtain a practicable comparison.

The pitch angle for minimum drag is well below the usual flying range so that a comparison of the minimum drags of floats is useful only as an indication of factors that affect the drag.

An appreciable part of the air drag of floats is caused by the chines, the step, and other such intersections, the chines apparently being the most important of these factors. So that the drag may be as small as possible, it is desirable that the chines be as nearly parallel to the direction of the air flow as is practicable (reference 1).

The minimum drag of each model and the angle of pitch at which it occurs are given in the following table:

N.A.C.A. model	$(\text{vol})^{2/3}$ $(\text{ft.})^2$	$C_{D_{min}}$	Pitch angle (deg.)
51-E	1.131	0.0360	-12
51-F	1.122	.0265	-4
51-G	1.122	.0220	-10
51-H	1.122	.0280	-2
51-J	1.131	.0310	0

Inboard Floats

The order of merit of the inboard floats based on minimum drag is models 51-G, 51-F, and 51-H.

The longitudinal lines of model 51-G are favorable to low minimum drag. Both the chine lines and the deck lines are probably as nearly parallel to the longitudinal axis of the float as practicable and the float is tapered in plan form as well as in profile, giving only a small cross-sectional area at the stern. The step and the wide blunt stern of model 51-H are probably responsible for its high minimum drag.

The afterbody chines of model 51-H are inclined at a slight negative angle to the keel at the step so that, at the angle for minimum drag, -2°, the chines near the stern are at a greater angle to the relative wind than the chines of models 51-F and 51-G. Part of the difference in minimum drag and in the angle for minimum drag might be caused by this difference in the chine angles.

It is to be noted that, in the flying range, the order of merit of the floats is reversed. The lower values of drag of model 51-H are probably partly due to the afterbody chine angle, which places the chines close to the stern more nearly parallel to the relative air flow than the chines of models 51-F and 51-G. The advantage of model 51-H could, however, be discounted by a 2° reduction in the rigging of model 51-F. The high drag values of model 51-G are obviously caused by the curvature of the keel

because the tangent to the keel at the stern is at an angle of about 10° relative to the longitudinal axis of the float.

Outboard Floats

Model 51-J is superior to model 51-E as regards both the minimum drag and the low drag in the flying range. At the nose, the chines of model 51-E are at a somewhat steeper angle than those of model 51-J, which probably accounts for part of the difference in drag. The afterbody keel angle of model 51-E is much too large for low drag and very likely sets up a highly turbulent wake.

A comparison of the drag of the inboard and the outboard floats again shows the importance of keeping the chine angles as nearly parallel to the wind direction as possible. The inboard floats are longer than the outboard floats; lower chine angles and, consequently, lower drag result.

The chines at the bow are also higher on the outboard floats than on the inboard floats, so that the chine angle is even larger. Making the chine at the bow as low as possible might result in a smaller value of air drag.

CONCLUSIONS

1. The chine at the bow should be no higher than required by hydrodynamic considerations so that the air drag may be a minimum.

2. A method to lower the angle at which floats are rigged appears to be an excellent way of reducing the air drag of floats.

3. Some floats with steps have lower drag in the flying range than similar floats without steps.

Langley Memorial Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., November 16, 1938.

REFERENCES

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5. Wenzinger, Carl J., and Harris, Thomas A.: Tests of an N.A.C.A. 23012 Airfoil with Various Arrangements of Slotted Flaps in the Closed-Throat 7- by 10-Foot Wind Tunnel. T.R. No. (to be published), N.A.C.A., 1939.

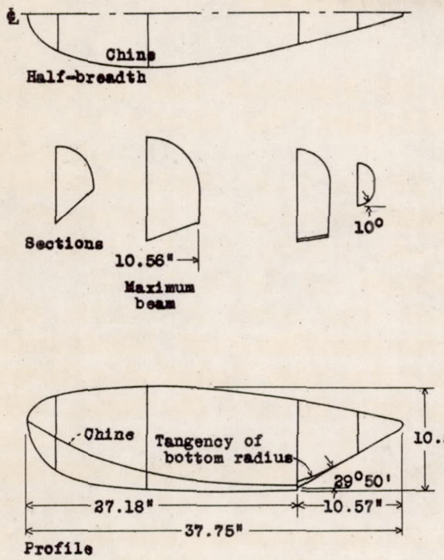

Figure 1.- Lines of N.A.C.A. model 51-E.

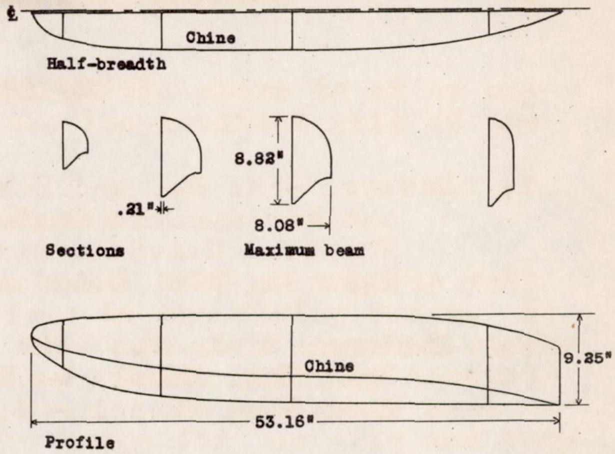

Figure 2.- Lines of N.A.C.A. model 51-F.

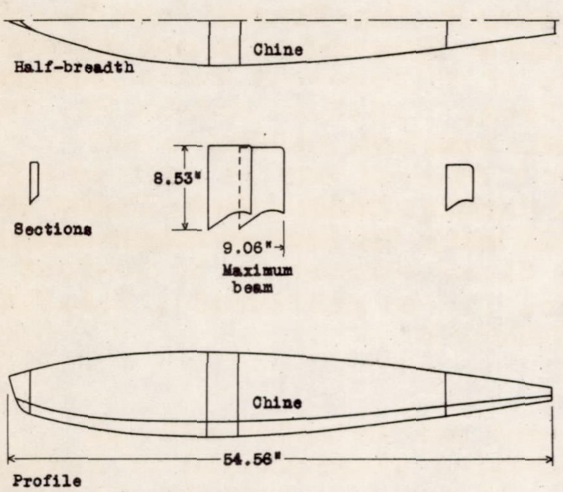

Figure 3.- Lines of N.A.C.A. model 51-G.

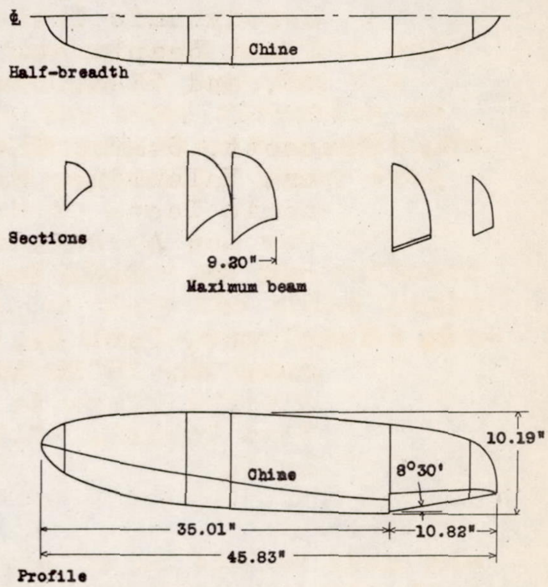

Figure 4.- Lines of N.A.C.A. model 51-H.

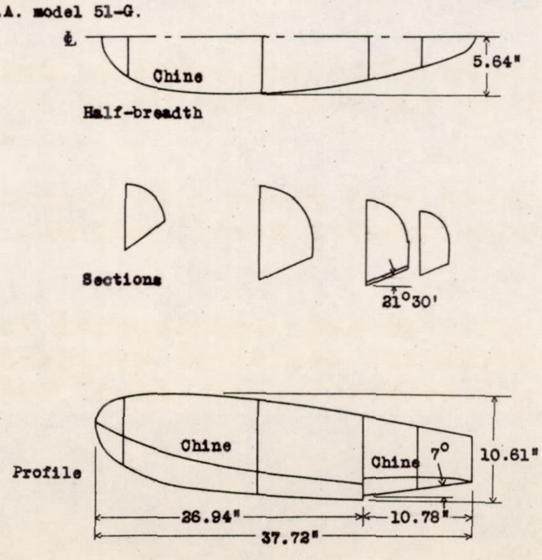

Figure 5.- Lines of N.A.C.A. model 51-J.

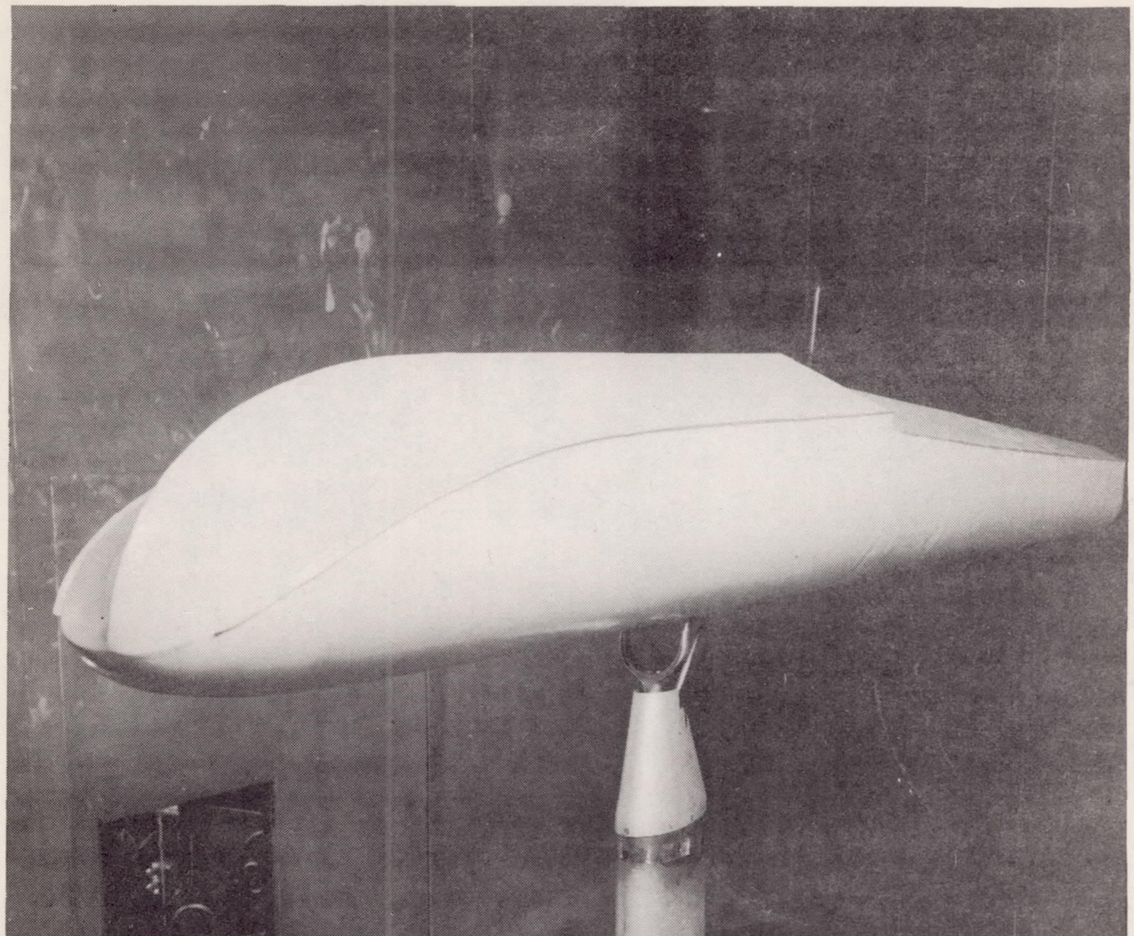

Figure 6.- Typical float installation in the 7- by 10- float wind tunnel. (Model shown not reported)

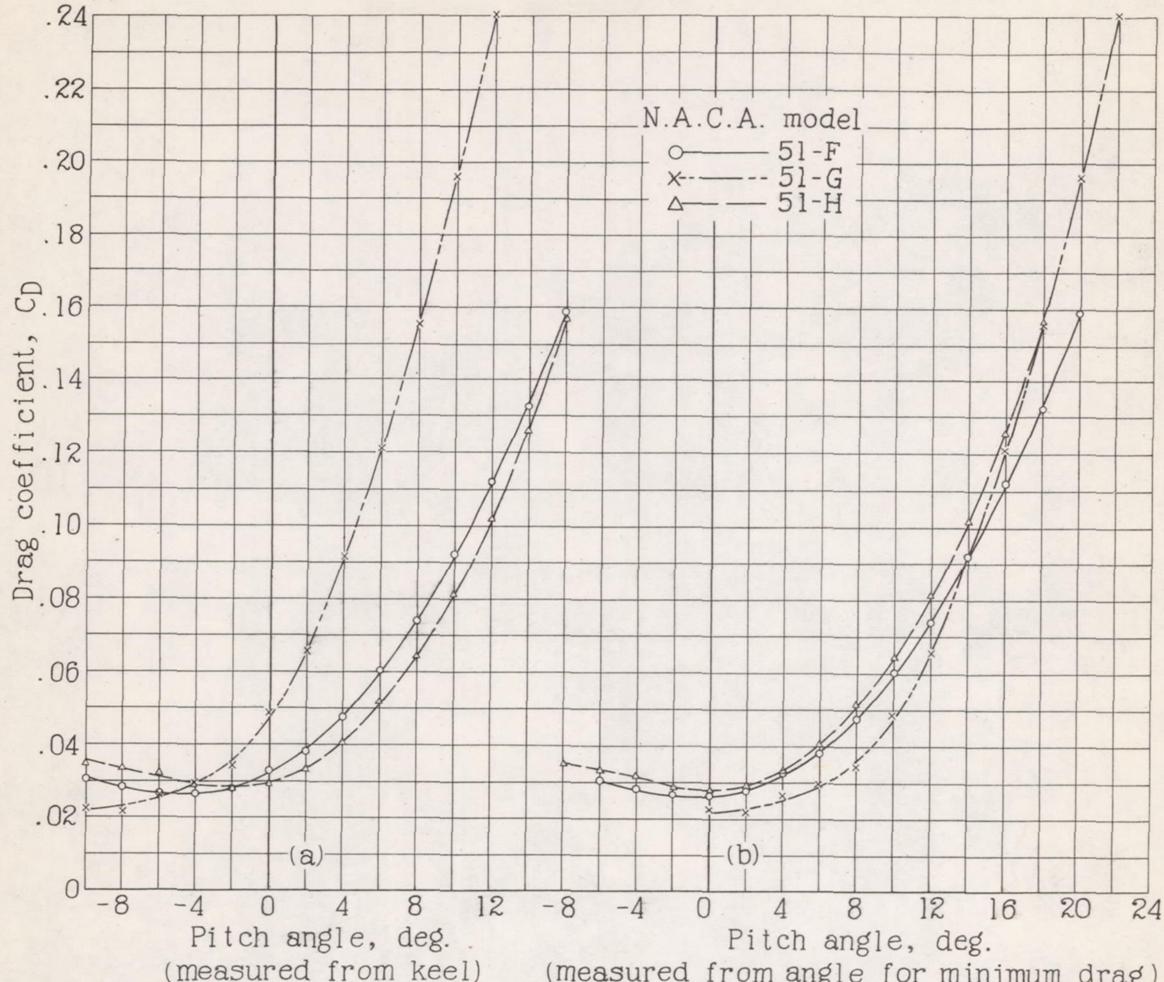

Figure 7.- Variation of drag coefficient C_D with pitch angle for inboard floats.

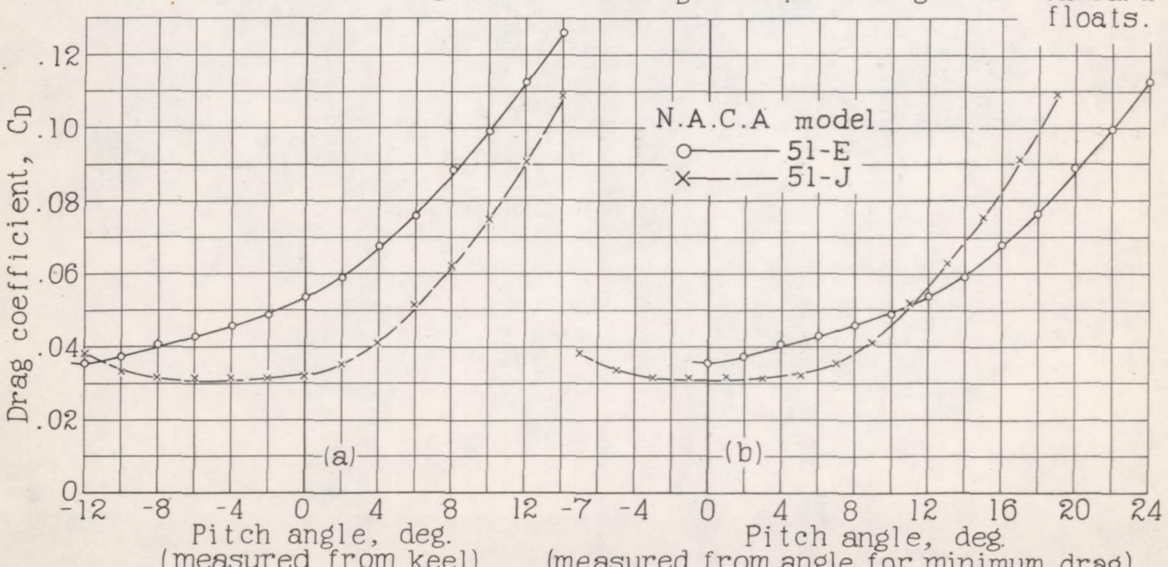

Figure 8.- Variation of drag coefficient C_D with pitch angle for outboard floats.